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Teaching Mathematics to Korean Language Learners: Application of ELL Education Models

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Abstract

As the population of linguistically and culturally diverse students increases, Korean educators and practitioners encounter the needs to change the school system and pedagogies. The situation in South Korea is unique in the sense that there is a group of Korean-born students returning from long stays in foreign countries who have lost their fluency in Korean. We define these students and immigrant students as Korean language learners (KLLs) and make suggestions about teaching strategies for them. We first examine a part of the Korean fourth grade mathematics textbook and English language learner education models that have been used in the US and Canada. Finally, we design a sample lesson based on our findings and ELL models.

Key words: linguistically and culturally diverse learners, South Korean education, mathematics education, ELLs, KLLs (Korean Language Learners), Cummins, SIOP Model, multicultural, diversity, the area of rectangle

Introduction

South Korea has been considered as a single culture country for a long time, but things changed recently. With the increase of international marriage and industrial needs, the population of immigrants has rapidly risen and it affects Korean school culture. The current situation in Korean schools is unique in the sense that the students identified as linguistically and culturally diverse learners are not only immigrant children but also Korean "returning students," who had lived in foreign countries for a long time. Since

these two groups of students usually demonstrate a lack of Korean language proficiency and a limited knowledge on school culture, they have difficulties adjusting into Korean public schools (Cho, & Lee, 2010). We define these students as Korean language learners (KLLs). Recent studies revealed that KLLs make lower achievement on academic performance than their peers and suggested culturally relevant instructions, but few researchers (Song, Moon, & Ju, 2011) paid attention to specialized instructions that address students' linguistic diversity.

The Korean public schools now offer special classes in elementary and middle schools for returning students in order to provide intensive Korean speaking and reading instruction. However, these classes serve less than 10% of the whole population of returning students and there is little or no service for immigrant students (Ministry of Education, Science and Technology, 2011). The majority of KLLs are educated in general classrooms by teachers who have not received any training of multicultural education. We address this unique situation of Korean schools and aim to provide applications and strategies for teaching mathematics to KLLs with non-KLL students.

Framework

The United States and Canada have highly diverse population including English language learners (ELLs). This situation leads them to conduct substantial studies about ELL education. Among them, we benchmark Cummins' Quadrants Model (Cummins, 1984) and Sheltered Instruction Observation Protocol (SIOP) Model (Echevarria, Vogt & Short, 2004) and apply them to structure meaningful mathematical lesson for KLL students.

1. Cummins' Quadrants Model

Cummins (1984) defined language as Basic Social and Interpersonal Communication Skills (BICS) and Cognitive Academic Language Proficiency (CALP) in academic perspectives. He created a two-dimensional model in which the horizontal axis represents a degree of context and the vertical axis represents a degree of cognitive demand. We concluded that a lesson in the quadrant B, which provides sufficient contexts and highly cognitive activity, is appropriate for teaching KLLs.

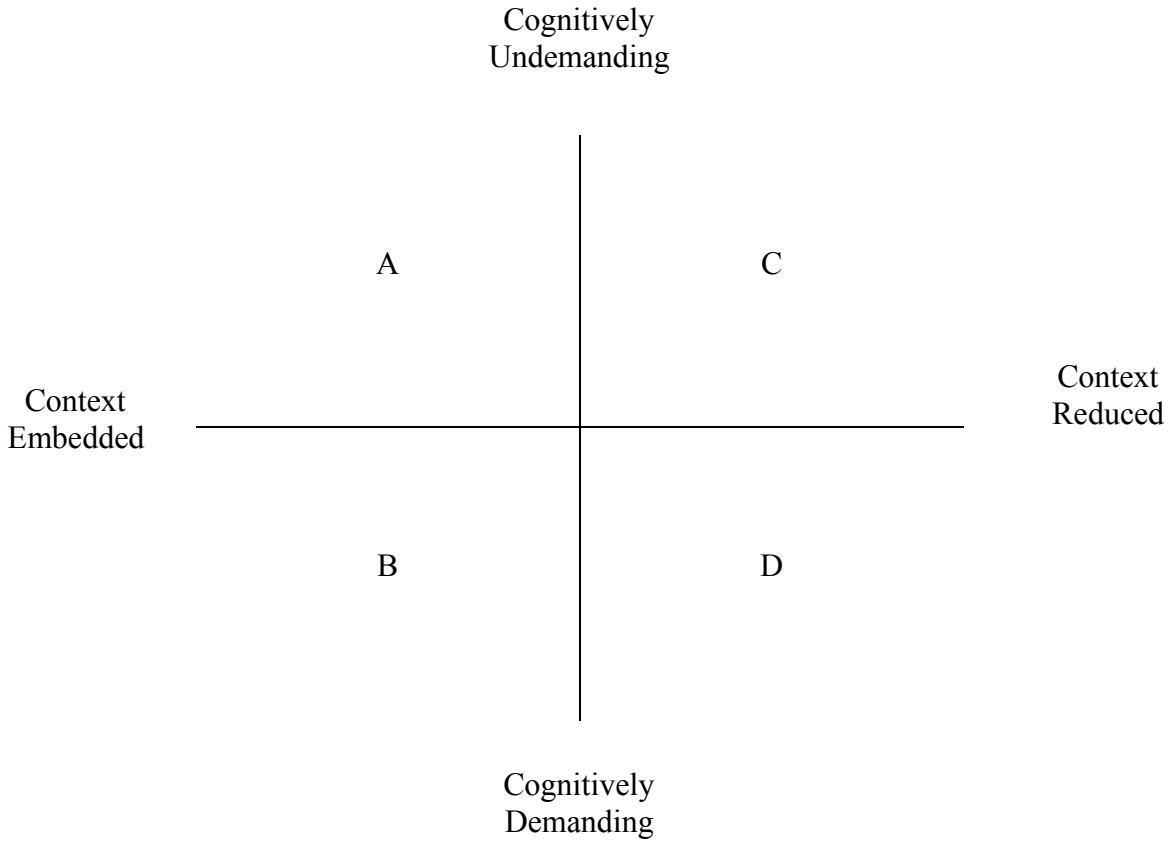

Figure 1. Cummins quadrants model (Cummins, 1984)

2. SIOP Model

The SIOP Model (Echevarria, Vogt & Short, 2004) is a framework that was developed to teach general subjects such as history or mathematics for English language learners (ELLs). This model is composed of eight elements: lesson preparation, building background, comprehensible input, strategies, interaction, practice/application, lesson delivery, and review/assessment. These elements are not chronologically ordered. We organized these eight elements into two categories: elements considered during instruction and elements considered outside classroom or before/after instruction. Since we make a connection with textbook materials, which illustrate a sequence of lesson delivery, we focus on the elements considered during instruction such as comprehensible input, strategies, interaction, and practice/application.

Method

We first studied and examined ELL education models: the Cummins Quadrant Model and the SIOP Model. Based on two frameworks, a selected part of the Korean elementary textbook was closely analyzed to address the following questions: What kind of language is included in texts? To what extent are various contexts embedded properly for KLLs? What strategies and applications are provided to engage students?

In Korea, teachers generally use the official textbooks thoroughly (Lee, 2000). Hence, the influence of textbooks is significant. We assume that the textbook contents generally represent the main part of class instruction. The area of rectangle lesson was chosen from the fourth grade mathematics textbook because the majority of KLLs are enrolled in elementary schools (Ministry of Education, Science and Technology, 2011). The formula of the area of rectangle is fundamental to deduce formulas of other geometric shapes. After examining the part of the textbook based on the Cummins' Quadrants Model and the SIOP Model, we provide a sample lesson application.

Result

1) Application of ELL Models to mathematics classroom

First, we analyzed each ELL model and applied them to mathematical activities. Typical mathematics lessons do not include situations familiar to students, although cognitively demanding activities are often required. We matched mathematical activities to each quadrant of Cummins' model (Table 1).

Table 1. Examples of Mathematical Activities in Cummins' Quadrant Model

Quadrant	Example
A	Introduce geometrical shapes with real objects
B	Solve linear equations with one variable using weighing experiments Design a house with various ratios and proportions
C	Practice simple operations, Memorize times tables
D	Lecture about the properties of isosceles triangles, Algebraic proof

Table 2 contains a brief description and possible applications in mathematics for some elements of the SIOP Model. Although the activities are initially categorized into a strongly connected element, they are often related to other elements depending on how the activity is used by an instructor. It is important to view the activities as a whole rather than one independent component. These activities should be designed with higher order thinking questions, various group changes, and reinforcing language learning.

Table 2. Examples of mathematical activities in each in-class element of the SIOP Model

Element	Example
Comprehensible Input	Graphic organizer, Demonstration, Visual aids
Strategies	Role playing, Group activity, Vocabulary memory aids
Interaction	Q & A, Small group discussion, Appropriate wait time Kinesthetic activity
Practice/Application	Hands-on practice, Game, Vocabulary review

2) Evaluation of the Korean mathematics textbook

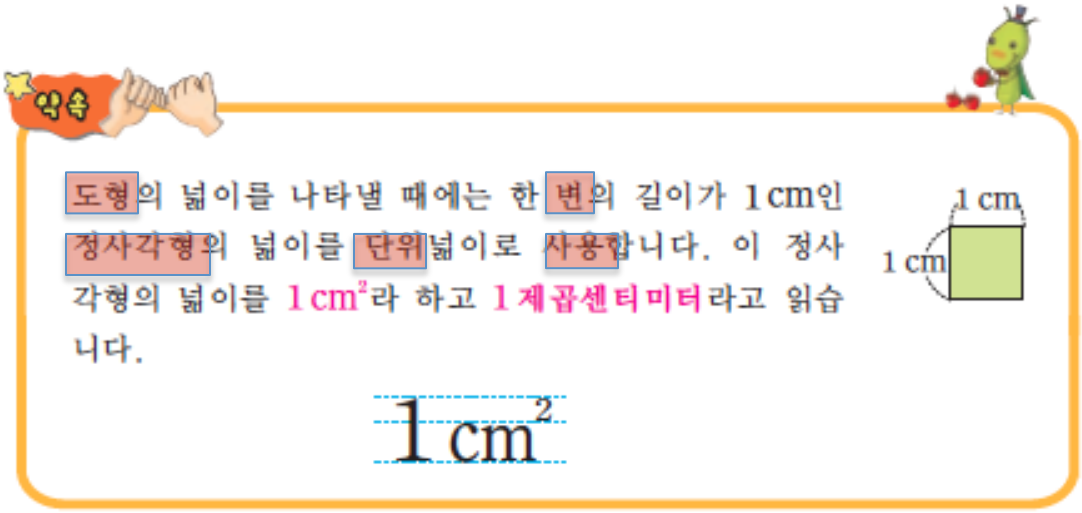

Figure 2. The use of Chinese character roots in elementary textbooks (Ministry of Education, Science and Technology, 2010)

Many Korean academic words in textbooks contain Chinese character roots that are not usually used in everyday language. Since Chinese characters can deliver an abstract meaning in one letter, they are convenient to use for indicating complicated concepts. However, those words are unfamiliar to KLLs and likely to distract them from understanding teachers' instruction. Therefore, examining the use of academic words became the initial focus of evaluating the textbook. The Korean elementary mathematics textbooks generally consist of a sequence of questions, and newly introduced concepts are briefly explained in a small box. We found that many words in instruction parts of the current Korean fourth grade mathematics textbook (Ministry of Education, Science and Technology, 2010) contain Chinese character roots. For example, two sentences in one concept box include five words that contain Chinese character roots (Figure 2). Three of them are mathematical terminologies that students are supposed to learn in earlier grades, and two of them are used in everyday language, but KLLs may have difficulty with those words if they do not have enough experience about Korean culture.

The Korean elementary mathematics textbook series do not provide all procedures and concepts that students are supposed to learn. In general, teacher instruction covers the concepts and procedures that the textbook does not illustrate. This situation indicates that teacher roles are significant in elementary classrooms and if teachers do not provide sufficient verbal and non-verbal scaffoldings for KLLs, they do not have access to learn mathematics in school settings. KLL students' equal opportunities to learn as non-KLL students depend on how teachers prepare KLL-friendly approaches.

The textbook excerpt on finding area of rectangles is shown in figure 3. There are only three questions until students are expected to find the rule of rectangle areas. The first question (A) is "Count how many unit squares are in the given rectangle," the second (B) is "How many square centimeters is the area of rectangle?" and the last one (C) is "Write how to find areas easily." The fourth question (D) is for practice, "Find the areas of rectangular objects." There exist cognitive gaps between consecutive questions, although students are supposed to have prior knowledge such as areas are additive and what the square centimeter is. Some students may find some useful pattern, for example, multiplying the number of rows and columns gives them the total number of unit squares.

However, this textbook does not provide any description of the pattern or a statement of the rule at any place of the chapter. Without teachers' support and guidance, the textbook, alone, does not explain what students need to learn.

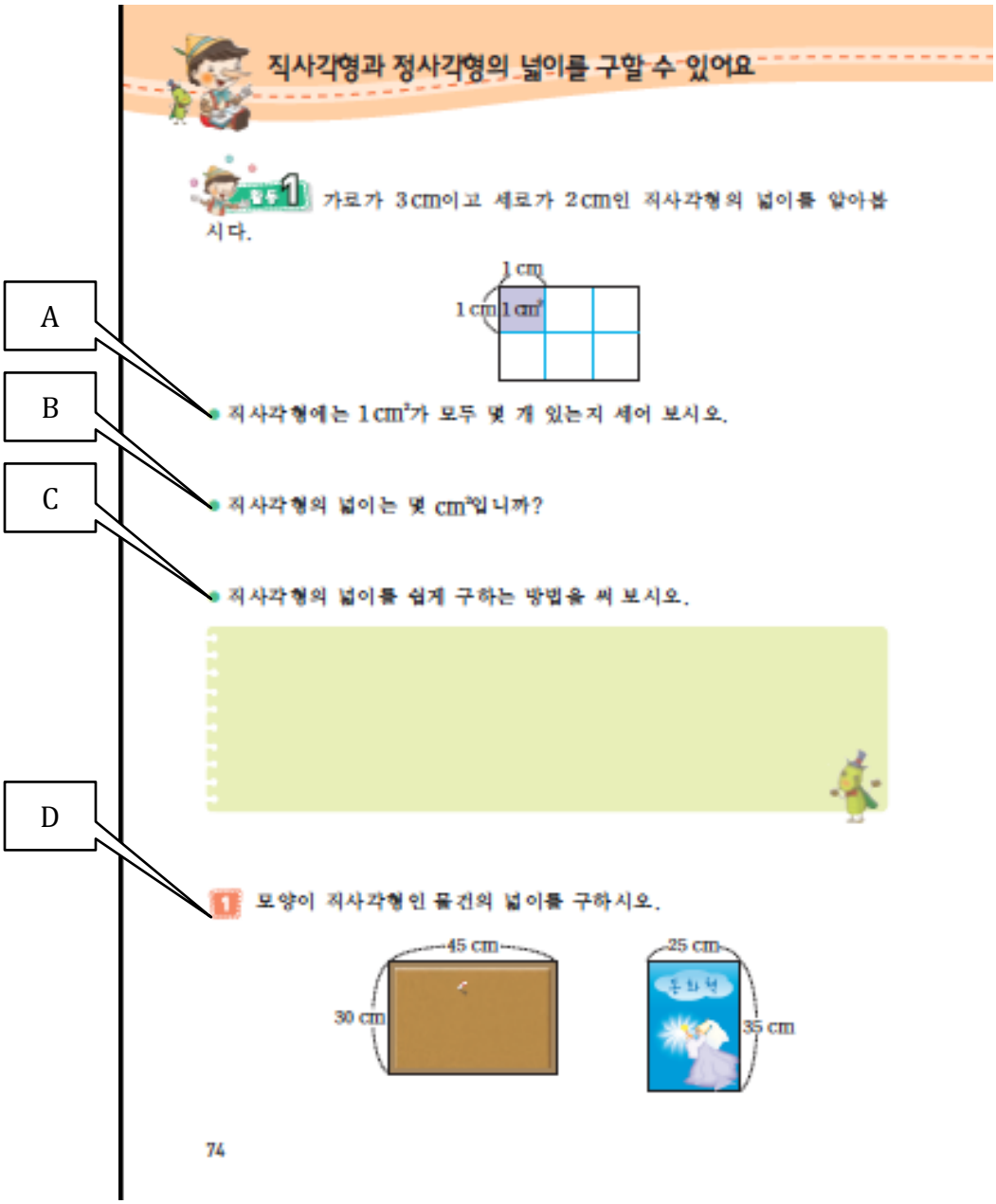

Figure 3. The area of rectangle instruction from the fourth grade mathematics textbook (Ministry of Education, Science and Technology, 2010)

3) Sample lesson

This is a suggested lesson specially designed for KLLs based on two frameworks. This lesson is intended to be cognitively demanding and context embedded as Cummins' quadrant B, and supported by appropriate language strategies, comprehensible input, and interactions as the SIOP Model recommends. Our intention is to supply missing parts of the textbook that teachers are supposed to fill out in order to provide meaningful input to KLL students.

The lesson starts with opening questions about students' experiences and prior knowledge. For instance, teachers can ask students to tell about pictures or objects of rectangular shapes and find common facts among the shapes. If there are students who are from other cultural backgrounds, using their cultural objects could build a connection to those students and encourage their participation (Song, Moon, & Ju, 2011). Some questions should tap into students' prior knowledge, especially the fact that areas can be added and compared. It is important for teachers to refrain from using formal language at this stage. For example, teachers should ask "which one is bigger?" rather than "which object has a greater area?"

Next, students work in groups, which are formed purposefully according to students' academic and linguistic ability. Each group is given a large rectangular paper and a set of square-shape adhesive notes (unit square tiles). The unit square tiles can completely fill out the large rectangular paper without overlapping or cutting. The task consists of two steps. First, students fill out the large rectangle with unit square tiles and second, they create another area unit to find more convenient ways to fill out the rectangle. In addition, students construct a written representation and a symbolic representation for the area they found. Teachers guide them to create an appropriate intermediate unit (Dougherty & Venenciano, 2007), which is usually a rectangular row or column. Figure 4 shows an example of unit area and an intermediate unit. In this example, five is the intermediate unit and iterating the intermediate unit four times will give the total number of unit tiles, which is the area of this rectangle. The intermediate unit could be four as the number of tiles in a column or eight, the number of tiles in two columns. There are many possible intermediate units that students could create to

completely cover the rectangle, but here we focus on a column unit (4) or a row unit (5) because we aim to guide students to find out the formula of the area of a rectangle.

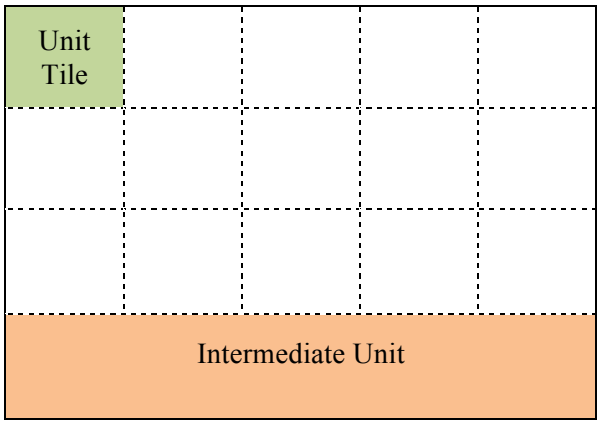

Figure 4. Example of the unit square and an intermediate unit

The opportunity to speak and write Korean in a small group helps language learners improve their language skills and build a safe learning environment (Garrison & Mora, 2005). The physical and visual activity provides non-verbal scaffolding so that KLLs overcome a language barrier. For practice and application, students find areas of various rectangular objects by measuring necessary parts and using the area formula they found. Students are encouraged to use not only a one foot ruler, but also centimeter or millimeter rulers so that they realize the value of areas could be different depending on what unit they choose. As reinforcement, a graphic organizer is applied at the end of the lesson. Barton, Heidema, and Jorda (2002) argue that graphic organizers help students understand mathematical and scientific concepts. The Frayer Model (Figure 5) would be a good fit for this activity.

Students have to write the definition, characteristics, examples and non-examples about one mathematical concept to complete the Frayer Model. Completing a graphic organizer helps KLLs demonstrate their learning and writing skills, so teachers can use it as an assessment, as well. The sample application provides various strategies including verbal and non-verbal scaffolding such as group work, hands-on activity, and cultural connection, as the SIOP Model recommends.

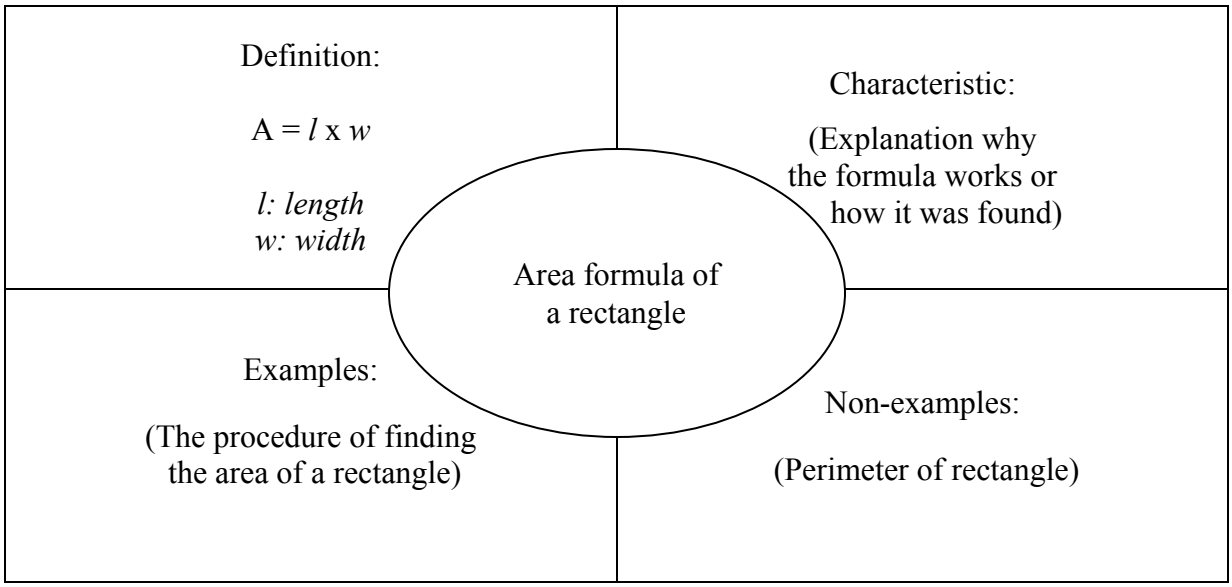

Figure 5. Frayer Model adjusted for the rectangle area formula activity

Conclusion

It is important to acknowledge that a teacher is the one who is able to see what works for her/his students. How teachers apply textbook contents makes a significant difference when the teacher is aware of the specific needs of her/his students. Although the textbook curriculum is not originally designed for a specific student population such as KLLs, teachers' appropriate adaptation could create a comfortable and effective learning environment for KLLs. Teaching KLLs and non-KLLs in the same classroom at the same time may challenge teachers, but this study proposes one possible way, as we describe in the suggested sample lesson.

In this paper, we identify research-based recommendations for teaching mathematics to linguistically and culturally diverse students, but further studies are needed to examine how KLL students perform in the suggested application. In addition, we focus on linguistic issues rather than cultural diversity because overcoming language barrier is a common issue between two groups of KLLs: returning Korean-born students and immigrant children. However, culture-based curriculum or culturally relevant pedagogy should be discussed in future studies. Finally, these recommendations could also be applied to teach abstract concepts in mathematics to other diverse students in other countries with different cultural or linguistic backgrounds.

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